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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Irradiation Device

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Abstract

The invention relates to an irradiation device for curing plastics, said device having a housing on which is arranged a light outlet. In order to provide an irradiation device of simple structure and low intrinsic weight, the light outlet possesses at least one light-emitting diode for emitting radiation in the wavelength range from approximately 320 nm to 550 nm.

Irradiation Device

The invention relates to an irradiation device for curing plastics, said device having a housing on which is arranged a light outlet, as well as to a method for operating the device.

Many such state-of-the-art irradiation devices are known. For example, DE 34 11 996 describes an irradiation device which is used to cure dental plastics. This device is designed as a hand-held unit, the housing of which contains a lamp, e.g. a halogen lamp, as the light source. The housing further contains the electrical connections required to generate the light, possibly a transformer to convert the mains voltage to the operating voltage required by the light source, as well as ventilation ducts, a fan and openings to dissipate the heat generated during operation of the irradiation device. Inside the housing the light is fed into a fibre optical light guide which serves as the light outlet; the light generated by the light source emerges from the end of this fibre optical light guide, which end is arranged outside the housing. The emerging light is used to cure plastics. The irradiation device known from DE 34 11 996 is a hand-held device which may be flexibly used to cure dental plastics; the curing process may take place both in the patient's mouth and, for example, on a work bench. In addition, stationary irradiation devices are known whose housings contain an irradiation chamber. In such devices, the light outlet is arranged inside the housing and is directed into the irradiation chamber. Stationary devices also exist in which a fibre optical light guide, which is used as the light outlet, is arranged to emerge on the outside of the device. In this case, a handle is arranged at the outer end of the fibre optical light guide, and the light guide is controlled by means of said handle. Such arrangements are used as hand-held devices in a manner similar to the arrangement described above, with the exception that, due to the limited length of the fibre optical light guide, their local operating range is restricted.

All such devices have a very complex structure because not only must light be conducted over a distance of varying length, for example by means of a

fibre optical light guide, but also the resulting heat must be dissipated in a suitable manner. Adequate heat removal requires that the housing be sufficiently large in size, and also necessitates the installation of additional components such as fans.

Proceeding from the state of the art as embodied in known configurations, the purpose of the present invention is to provide an irradiation device, and a procedure for operating the said device, the latter being simple in design, light in weight and at the same time capable of permitting optimum irradiation.

In the manner according to the invention, this task is solved by providing the light outlet with at least one light-emitting diode (hereinafter referred to as an LED) to emit radiation in the wavelength range from about 320 nm to about 550 nm, and in particular from about 400 nm to 500 nm. By this means, light-cured plastics may be cured. The heat generated when LEDs are used as the irradiation source is negligibly small so that the customary means used to dissipate heat are not required. In addition, the power can be supplied to the LED through a cable of almost any desired length, so that the components needed to generate the electrical energy, which are of sufficiently well-known design, may be permanently installed at a suitable location. As a result, the irradiation device itself can be very small and easy to carry and it has a very flexible range of use. For example, it is possible to lay out the power supply for such irradiation devices in a manner similar to that used for the customary mains supply, in which power can be tapped off at various plug receptacles. Thus, in order to carry out irradiation at various places, all that is needed is a housing which can be designed as a very small handle section on which is arranged the light outlet carrying the LED at its outer end. The irradiation device may be designed as a hand-held device or as a stationary unit. While in hand-held units the good handling properties and mobility are made possible by the small dimensions of the units, a stationary device can be closely adapted to the size of the irradiation chamber. In addition, the advantage of such an arrangement is

that the power requirement is much lower than in conventional units, because LEDs, as described above, are much more efficient than conventional light bulbs. Another consequence of this design is that the work can be performed with currents and voltages of lower strength, thus increasing the safety factor for the operator.

The irradiation device advantageously possesses a sensor or a similar arrangement to measure the intensity of the light emitted by the LED; the sensor is connected to an indicator, e.g. an optical indicator (which may also take the form of an LED), via an evaluation unit to evaluate and further process the intensity signal, so that the operator can be informed if the intensity of the radiation from the LED falls below a predetermined limit value. This is important because LEDs do not suddenly reach the end of their operating lifetimes, but instead slowly decline in intensity.

The housing possesses preferably a handle with a switch to make the device easier to use.

The semiconductor material used in the LEDs is advantageously a gallium nitride, silicon carbide or zinc selenide.

It is advantageous to bundle together several, and preferably three or five LEDs, to form a light source. This substantially increases the intensity. In particular, it is advantageous if the bundled LEDs are arranged in a common capsule, in which the light outlet side of the capsule is advantageously designed as an optical lens which is capable of focussing the light beam emitted by all the bundled LEDs. The capsule reduces the size of the device and permits better handling of the LEDs during assembly. Furthermore, the light beams can be better directed because of the small number of light sources.

The underlying task of the invention, namely to find a procedure for operating the device of the type described above, is solved by supplying a

pulsed operating current to the LED. This permits a much higher intensity to be achieved. An LED which can be operated at a constant current of 20 mA can be operated at about 100 mA in the pulsed mode. This permits light intensities of about 1000 mcd to be achieved. It is advantageous to operate with pulse durations of in each case about 10 ms. The ratio between pulse and pause should be about 1:10. When several LEDs are bundled, it is advantageous to pulse each LED individually and out of phase with the others. The pulse frequency may be increased during operation so that stress build-up is avoided in the irradiated material. While the pulse frequency is being increased, or afterwards, the operating current of the LEDs can be increased to the maximum possible value. For the pulsed operation of the LEDs, it is possible to use the customary circuit arrangements which are well-known to the expert in the field.

The purpose of the invention is furthermore to use the irradiation device according to the invention to cure dental plastics. Very small quantities of such plastics are used in a dentist's surgery or in a dental technician's workshop. These small amounts of plastic can be very advantageously cured with the irradiation device according to the invention because the light beam of the LED is easy to guide. Because it is possible to design the housing and handle with very small dimensions, almost any desired point in the mouth of the patient can be irradiated.

According to the invention, the irradiation device may also be used to cure technical plastics, e.g plastics which are used by histologists or metallographers to embed specimens.

In the following, an embodiment of the invention is described in more detail on the basis of a drawing.

Fig. 1 shows a hand-held device according to the invention.

Fig. 2 shows a diagrammatic view of a stationary device according to the invention, and

Fig. 3 shows a top view (a) and a side view (b) of several LEDs encapsulated together.

As depicted in Fig. 1, the irradiation device according to the invention possesses a housing 1 having a wire 2 for supplying electric power. The housing 1 is designed as the housing of a non-stationary hand-held device. It possesses a handle 3 on which is fitted a switch 4. The handle is substantially cylindrical in shape, and at one end of the cylinder is arranged a light outlet 5, at the outer end of which is arranged the LED 6. The latter is based on gallium nitride. The light outlet 4 takes the form of a flexible rod which can be bent as required at the irradiation site. The LED 6 emits beams of light in the wavelength range from about 320 to 550 nm, in particular 400 to 500 nm. The irradiation energy influences the time needed to cure the plastic and may be appropriately regulated.

The irradiation device possesses a pilot LED which functions as an indicator 7 to signal the age-related drop in intensity of the radiation from the LED 6 below a predetermined limit value. Customary, known arrangements may be used to measure and evaluate the intensity of the radiation emitted by the LED 6.

Instead of the arrangement depicted in the drawing, other arrangements or configurations of a housing with a handle section are conceivable. For example, the entire housing 1 may be designed as a handle section 3, the said handle section 3 having the form of a thickened section of the light outlet 5.

Embodiments of the invention are also conceivable in which the light outlet comprises several LEDs; for example, a stationary irradiation device having an irradiation chamber arranged inside the housing 1 may possess a plurality

of LEDs 6 surrounding the irradiation chamber on several sides, so that a plastic part which needs to be cured can be uniformly irradiated from all sides. Figure 2 depicts such an irradiation device. Inside a housing 1 is arranged a customary irradiation chamber 8 which is surrounded by LEDs 6. The LEDs 6 may be arranged on a cage-like rack 9 around the mounting 10 for the part to be irradiated 11 (e.g. a dental component). In Figure 2, the indicator 7 is arranged on the housing 1 alongside operating elements which are not shown in the Figure.

The LEDs depicted in Figures 1 and 2 may be formed by bundled LEDs 6, as shown in Figure 3. For example, 3 or 5 individual LEDs 6 may be arranged in a capsule 12 having a common convex lens 13. The LEDs 6 may be operated by a pulsed current of 100 mA, and the ratio of impulse duration to pause duration is 10 ms to 100 ms (1:10). This makes it possible to achieve a light intensity of 1000 mcd. From the start of the irradiation, the pulse frequency and the current are continuously increased. This increase in the intensity prevents the build-up of stresses in the material being irradiated (dental or technical plastics).

Claims

1. An irradiation device used for curing plastics, said device having a housing on which is arranged a light outlet, characterized in that the light outlet (5) possesses at least one light-emitting diode (LED) (6) for emitting radiation in the wavelength range from approximately 320 nm to 550 nm.

2. An irradiation device according to Claim 1, characterized in that the housing (1) possesses a handle (3) with a switch (4).

3. An irradiation device according to Claim 1 or 2, characterized in that a sensor is provided to measure the intensity of the light emitted by the LED (6), said sensor being linked via an evaluation unit to an indicator (7) to indicate a drop in the light intensity of the LED (6) below a pre-determined limit value.

4. An irradiation device according to one of the Claims 1 to 3, characterized in that the semiconductor material of the LED (6) is a gallium nitride, silicon carbide or zinc selenide.

5. An irradiation device according to one of the Claims 1 to 4, characterized in that it is designed as a hand-held device.

6. An irradiation device according to one of the Claims 1 to 4, characterized in that it is designed as a stationary unit.

7. An irradiation device according to one of the Claims 1 to 6, characterized in that in each case several, preferably 3 or 5, LEDs (6) are bundled to form a light source.

8. An irradiation device according to Claim 7, characterized in that the bundled LEDs (6) are arranged in a common capsule (12).

9. An irradiation device according to Claim 8, characterized in that the light outlet side of the capsule (12) is designed as an optical lens (13).

10. A procedure for operating a device according to one of the Claims 1 to 9, characterized in that the operating current supplied to the LEDs (6) is pulsed.

11. A procedure according to Claim 10, characterized in that the pulse duration is approximately 10 ms.

12. A procedure according to Claim 10, characterized in that the pulse/pause ratio is approximately 1/10.

13. A procedure according to Claim 10, characterized in that several LEDs (6) are supplied individually and out of phase with pulsed current.

14. A procedure according to Claim 10, characterized in that the pulse frequency is increased while the device is in operation.

15. A procedure according to Claim 14, characterized in that the strength of the operating current supplied to the LEDs (6) is increased while or after the pulse frequency is raised.

16. The use of the irradiation device according to Claim 1 to cure dental plastics.

17. The use of the irradiation device according to Claim 1 to cure technical plastics.

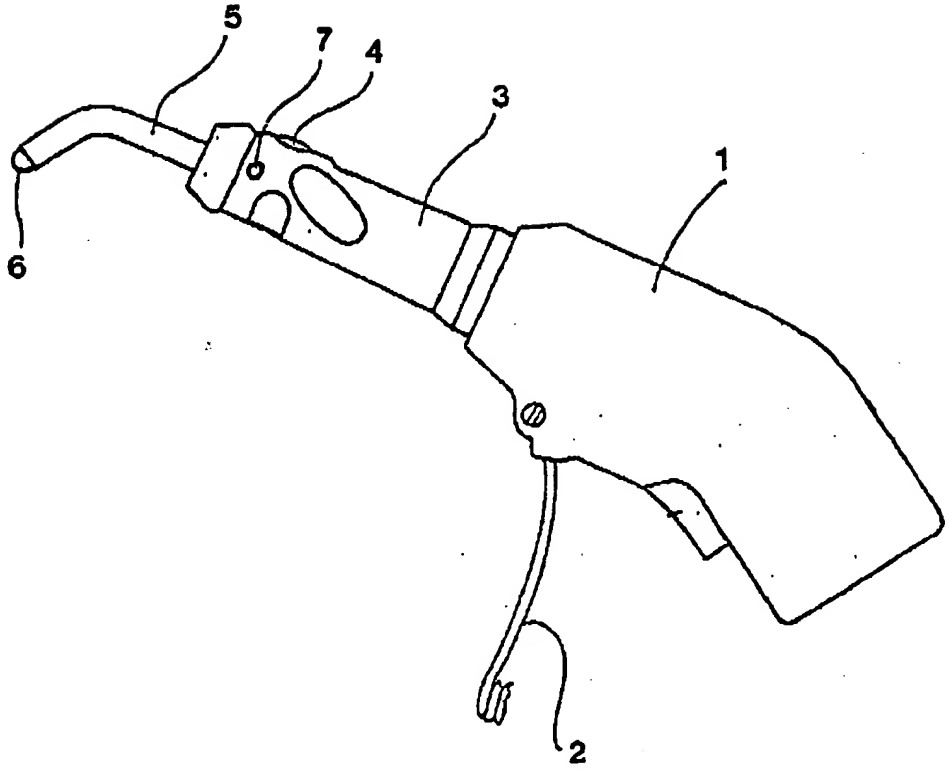

Fig.1

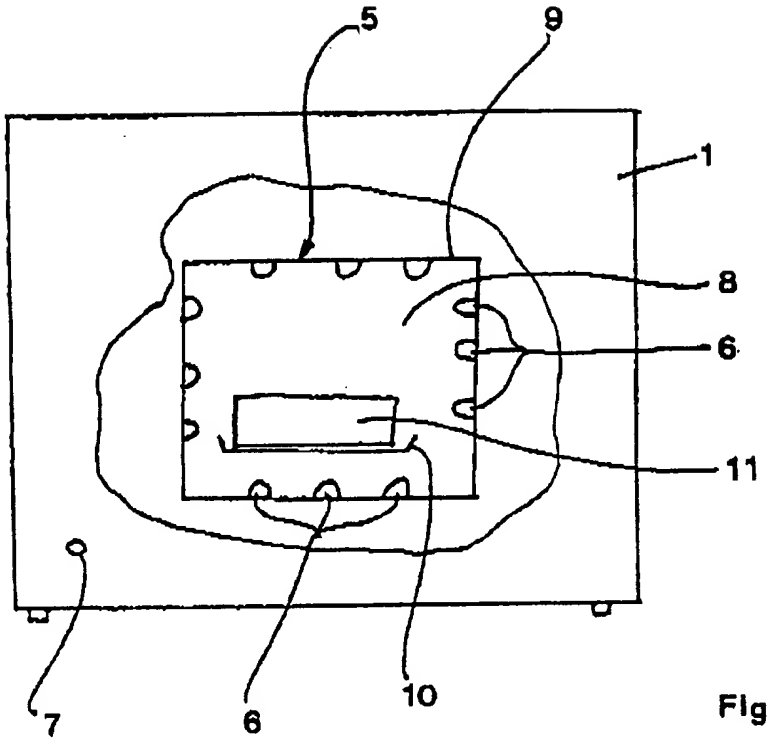

Fig. 2

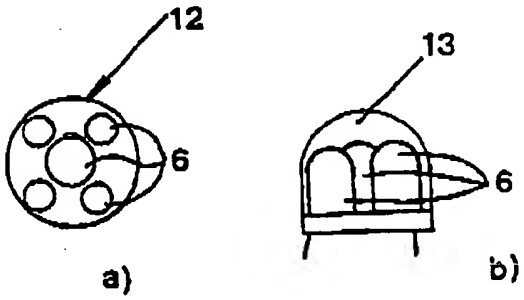

Fig. 3